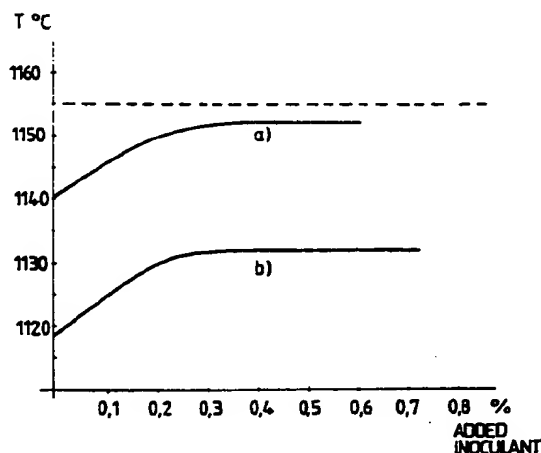




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/SE91/00144 (22) International Filing Date: 25 February 1991 (25.02.91) (30) Priority data: 9000678-4 26 February 1990 (26.02.90) SE (71) Applicant (for all designated States except US): SINTER-CAST LTD. [GB/GB]; Alfa Tower, Great West Road, Brentford, Middlessex TW8 9BT (GB). (72) Inventor; and (75) Inventor/Applicant (for US only) : BÄCKERUD, Stig, Lennart [SE/SE]; Torsvikssvängen 42, S-181 34 Lidingö (SE). (74) Agents: KIERKEGAARD, Lars-Olov et al.; H Albiñs Patentbyrå AB, Box 3137, S-103 62 Stockholm (SE).		(81) Designated States: AT (European patent), AU, BE (European patent), BR, CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European patent), GR (European patent), HU, IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), SU, US. Published <i>With international search report.</i>

(54) Title: A METHOD FOR CONTROLLING AND REGULATING THE PRIMARY NUCLEATION OF IRON MELTS



(57) Abstract

The invention relates to a method of regulating the solidification process in iron casting operations. This is effected by determining the intrinsic crystallisation ability of a base melt and modifying the same. A sample is taken from the base melt in a sample vessel which is in thermal equilibrium with the sample melt before solidification commences. The sample vessel is provided with at least one thermoelement and contains a given and calibrated quantity of inoculant on FeSi-base, this quantity being sufficient to provide a maximum inoculating effect. The sample melt is allowed to solidify and the difference between the lowest temperature in the undercooling phase prior to the eutectic reaction and the maximum temperature in the eutectic reaction phase and the eutectic equilibrium temperature is determined. When this difference exceeds 10 K and 5 K respectively, thermodynamically stable particles of the type spinels or oxysulphides of elements such as magnesium, calcium, zirconium, strontium, titanium and rare earth metals, are added to the melt. These procedural steps may be repeated until the temperature differences fall below the aforesaid limits.

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A method for controlling and regulating the primary
nucleation of iron melts

5 The present invention relates to a method for controlling the solidification process of a casting melt, by determining the intrinsic crystallisation ability of a melt and making those corrections that are necessary.

10 When producing cast iron of all conceivable types, it is very important to check the number of graphite crystals formed per unit of volume. In white cast iron no graphite crystals are formed; mottled cast iron has a few graphite crystals; grey cast iron and cast iron with compact graphite have a moderate number of graphite
15 crystals; and nodular iron normally has a large number of graphite crystals.

Consequently, a nucleation stimulant is introduced into the melt shortly before the casting process, in order
20 to stimulate the formation of a desired number of graphite crystals. A large number of nucleation stimulants are commercially available, the majority of these stimulants being based on ferrosilicon (FeSi) or silicon carbide. Many of these stimulants contain so-called
25 inoculating agents and also certain additive elements, such as calcium, strontium or zirconium, with the intention of amplifying the effect of the stimulants.

The effect produced by the inoculating agents is very
30 shortlived, however, and these agents must therefore be added to the melt at a late stage of the casting process, often in the casting jets or even in the actual casting mould itself. It is obvious that the effect of such additives is difficult to monitor and control in a
35 manner to achieve optimal results, since the

inoculating effect achieved will vary from melt to melt, and therewith from product to product.

5 The mechanism through which nucleation of graphite crystals takes place in the presence of FeSi-particles (the substance is most normally added in the form of coarse granules having a size of 1-10 mm) is well described in the literature (see for instance Ch Wang and Fredrikson; 48th International Casting Congress in 10 Varna, Bulgaria, 1981-10-4--7, 255).

The carbon equivalent (i.e. C.E. = % C + % Si/4) will increase sufficiently in the diffusion zone that occurs when an FeSi-particle is dissolved in the melt for a graphite crystal to graphitize in the melt, 15 provided that this small graphite crystal survives until its normal growth temperature has been reached (i.e. generally at a temperature < 1155°C). Under such circumstances, the graphite crystal is able to develop 20 to a flaky graphite crystal or a graphite nodule, depending upon the chemical environment prevailing in the iron melt. Whereas Wang and Fredrikson state that the formation of graphite crystals takes place through an homogenous nucleation process, several other 25 authors, for instance Jacobs et al, Metals Technology, March 1976, page 98 (page 102) state the opinion that the formation of graphite crystals is a heterogenous nucleation process. These authors have namely found in graphite crystals primary crystallisation nuclei which 30 consist of complex oxides of such elements as calcium, magnesium and aluminium of the spinel type, which are thermodynamically stable and well dispersed in the melt. The present invention is based on the significance of these so-called primary nuclei.

5 The concentration of such primary nuclei in the base melts used in present day casting technology varies considerably, partly due to the starting material used; this starting material ranges from sponge iron, material recycled from the foundry concerned, to steel scrap and more or less well defined scrap purchased on the market.

10 The melting method used also plays an important part. Furnaces operate in accordance with different principles (for instance gas-fired or oil-fired cupola furnaces, light-arc furnaces and induction furnaces), which heat the base iron to different temperatures during the melting process. Furthermore, the furnace
15 linings influence the sulphide, oxysulphide and oxide particles in the molten material. Consequently, the concentration of primary nuclei in the base melt will vary very widely, not solely from the one production line to the other, but also from batch to batch in one
20 and the same production line.

It is known many patent specifications disclose valuable information concerning the properties of a melt. SE-B-350 606 in particular teaches a method in which a
25 sample of the melt is taken in a sampling vessel when casting aluminium and the temperature changes that take place in time as the melt solidifies are recorded with the aid of a thermoelement placed in the melt. These records are then used to anticipate crystallisation
30 conditions on the basis of undercooling values, the slope of different parts of the curve, and constant temperatures during the eutectic reaction. SE-B-444 817 teaches a method by means of which information concerning the properties of the melt can be obtained such as
35 to be able to determine whether the melt will solidify

as flaky graphite iron, as a compact graphitic iron or as nodular iron.

This information is obtained with the aid of two thermoelements, one of which is placed in the melt in the centre of a sampling vessel and the other is placed in the melt in the proximity of the wall of said vessel.

According to the present invention there is provided a method for regulating the solidification process in the casting of iron, this method comprising the steps of determining the intrinsic crystallisation ability of a base iron melt and modifying this ability, said method being characterized by taking a melt sample in a sampling vessel which is in thermic equilibrium with the sample quantity prior to solidification commencing, said sampling vessel having been provided with at least one thermoelement and containing a determined and calibrated quantity of inoculating agent based on FeSi and sufficient to produce a maximum inoculating effect; allowing the sample melt to solidify while recording temperature changes per unit of time; determining the difference between the minimum temperature in the undercooling phase, the maximum temperature in the eutectic reaction phase, and the eutectic equilibrium temperature T_e ; adding to the base melt thermodynamically stable particles of the type spinels or oxysulphides of elements such as magnesium, aluminium, potassium, zirconium, strontium, titanium and rare earth metals when the difference between eutectic equilibrium temperature T_e and the minimum temperature in the undercooling phase exceeds 10 K and when the difference between T_e and the maximum temperature in the eutectic reaction phase exceeds 5 K; and if found suitable repeating these method steps until the aforesaid difference falls beneath 10 K and 5 K

respectively.

5 The formation of oxides and/or oxysulphides is promoted when sulphides are present in the melt, such as manganese sulphide. The oxides may be of the spinel type, for instance spinel MgAl_2O_4 , or of the oxysulphide type, such as $\text{Ce}_2\text{O}_2\text{S}$.

10 When only one inoculant, such as FeSi, is added to a base graphite iron melt which contains only a very small amount of primary nuclei, practically no inoculating effect is obtained. The same applies when an inoculant consisting of spinels and/or oxysulphides is added to this base melt. However, if the relatively
15 stable spinels and/or oxysulphides are added first and FeSi is added thereafter in conjunction with the casting process, a desired, controllable inoculating effect is obtained.

20 The inoculant added to the sampling vessel in a calibrated and determined quantity is preferably a known, commercially available inoculant, such as an inoculant of the type known as "Superseed", having a particle size of from 2-4 mm. The amount of inoculant added
25 shall correspond, for instance, to 0.2% of the total weight of the sample, subsequent to filling the sampling vessel with molten iron to the rim of said vessel. The minimum temperature during the undercooling phase which releases the eutectic reaction, and the
30 maximum temperature during the eutectic reaction, are then determined with the aid of temperature measuring devices, preferably thermoelements, placed in the sampling vessel. The melt will contain a sufficient number of primary crystallisation nuclei when the
35 minimum temperature is less than 10 K beneath the

equilibrium temperature. In this context, the eutectic temperature has been defined as 1150°C and the thermoelements have been calibrated accordingly.

5 If the measured minimum temperature is beneath these defined temperature limits, it is necessary to add a given, calibrated amount of primary nuclei to the melt. As a rule of thumb, it can be said that the amount of primary nuclei added to the melt is doubled for each
10 further 5 K interval by which the measured eutectic reaction temperature falls beneath the eutectic equilibrium temperature.

The method by which crystallisation nuclei are added
15 can vary. Oxides and oxysulphides can be introduced to the melt through the medium of suitable fluxes, although a better result is obtained when the stable particles are formed directly in the melt to achieve optimal dispersion and wetting. Calcium, aluminium,
20 magnesium, strontium, zirconium, cerium or other rare earth metals in elementary form can be introduced in accordance with injection metallurgical principles with the aid of an inert carrier gas containing a measured amount of oxygen, or metal powder can be mixed with a
25 readily disassociated oxide, such as iron oxide, and introduced into the base melt in the casting stream or jet when transferring the melt to a holding furnace, or with the aid of a dipping ladle in the holding furnace. A more sophisticated method is one in which powder is
30 enclosed in a tube of appropriate diameter and fed into the melt with the aid of a wire feeder.

Because of the high carbon activity, and therewith low oxygen potential, it may be difficult at times to
35 achieve an effective oxide formation of the kind

desired, by introducing additives directly to a cast iron melt.

5 One alternative is then to produce a master alloy having a high content of oxide/oxysulphide particles from a separate melt having a low carbon content, and to dilute this master alloy in the melt to be treated. This master alloy, which will preferably contain at least 100 times the desired final particle concentra-
10 tion, can be produced in different solid forms, for instance in pellet form or in the form of small moulded pieces or in wire form, and can be introduced into the melt with the aid of suitable devices.

15 The master alloy used will preferably contain less than 5% of metals other than iron, thus more than 95% iron, and is preferably introduced to the molten iron in a quantity smaller than 1% of the total amount of cast iron.

20 A master alloy is produced by adding the desired metals present in oxides or oxysulphides in an environment such that oxidation with oxygen or sulphur will take place, and consequently the carbon content should be as
25 low as possible in order to prevent carbon present in the melt from having a negative influence on the oxidation process.

30 As beforementioned, when practising the inventive method undercooling is measured with the aid of at least one thermoelement placed in the sample quantity taken from the melt. In this respect, it has been found important to use two thermoelements, one placed in the centre of the sample melt and the other close to the
35 inner surface of th sample vessel wall, wherein th

difference between the minimum temperature in the undercooling phase for the eutectic reaction and the eutectic equilibrium temperature is determined with the aid of the thermoelement placed in the proximity of the inner surface of the sample vessel. The difference between the eutectic equilibrium temperature and the maximum temperature in the eutectic reaction phase is determined with the aid of the thermoelement placed in the centre of the sample. Should inverse segregation take place to an extent such that exudation of melt occurs, this can be observed from the rapid increase in temperature that takes place in the melt and recorded on the thermoelement positioned close to the inner surface of the sample vessel. The occurrence of exudation is evidence of the fact that the melt is deficient in crystallisation nuclei. Consequently, thermodynamically stable particles of the type spinels or oxysulphides must be added to the melt in quantities larger than those otherwise motivated by the minimum temperature of the undercooling phase measured in the centre of the sample vessel. The sampling process can then be repeated until the exudation phenomenon ceases and the aforesaid temperature differences lie between 10 K and 5 K respectively. Exudation is essentially due to a deficiency of crystallisation nuclei in the melt, and when a skin of solidified iron is formed at the inner surface of the sample vessel, the skin will contract and the melt located inwardly of the skin will penetrate the skin and cause molten metal to be pressed out through the skin wall. The thermoelement positioned adjacent the inner wall of the sample vessel will therewith register an elevated temperature.

One important advantage afforded by the inventive method is that a base-inoculant of an FeSi-type can be

used in combination with a modifying agent of the spinel or oxysulphide type. The base-inoculant is relatively inexpensive in comparison with a modifying inoculant.

5

The following series of tests illustrate how the effect of inoculant additions can vary from one production line to another. This variation is shown in Figure 1, which illustrates the effect obtained when adding an amount of inoculant to the melt, and also shows the minimum undercooling temperature which precedes the eutectic reaction.

10

Different quantities of a commercially available inoculant of the FeSi-type with an addition of strontium, "Superseed", were added to a base iron.

15

a) A base iron containing a sufficient quantity of primary nuclei

20

A thermoanalysis of the undercooling temperature prior to the eutectic reaction gave the measurement values disclosed in Figure 1, where the minimum temperature is plotted as a function of the amount of inoculant added, expressed in percent by weight of the sample melt. It will be seen from curve a) that a full inoculating effect was measured with an addition of 0.2% inoculant and that the minimum temperature lies close to the eutectic equilibrium temperature, i.e. 1150-1155°C. A metallographic examination showed fully developed A-graphite or flaky graphite throughout the whole of the sample volume.

25

30

b) A base iron with an insufficiency of primary nuclei
The same type of inoculant was added as that according to curve a) above, although in this case the addition

35

was made to a base iron melt having an insufficiency of primary nuclei, as illustrated in curve b), the minimum temperature in this case lying on a much lower level. The minimum temperature of the eutectic reaction will
5 never reach those values characteristic of a well inoculated material of A-graphite type, irrespective of the amount of inoculant added. When adding 0.25% inoculant, the samples, when examined metallographically, showed a relative quantity of D-graphite, "undercooled graphite", reaching to 40-60% of the
10 total amount of graphite in the sample.

It will be seen from the curves in Figure 1 that an addition of a given inoculant of the FeSi-type in
15 quantities above 0.2% will not appreciably influence the inoculating effect.

It is possible on the basis hereof to devise a simple measuring method by means of which the concentration of
20 primary crystallisation nuclei in the melt can be established. This measuring or assaying procedure is effected by first introducing a molten inoculant of the FeSi-type into the sample melt in an amount corresponding to at least 0.2%, and thereafter recording the
25 minimum temperature prior to the eutectic reaction and the maximum temperature at the eutectic reaction and comparing the values obtained with the eutectic equilibrium temperature.

30 The concentration of primary crystallisation nuclei in the melt can then be adjusted, in accordance with the invention, so that conditions which are optimum for graphite precipitation in the melt casting process are obtained.

5

CLAIMS

1. A method for controlling the solidification process in iron casting operations, comprising the steps of
10 determining the intrinsic crystallisation ability of a base iron melt and modifying said ability, characterized by taking a melt sample in a sampling vessel which is in thermic equilibrium with the sample quantity prior to solidification commencing,
15 said sampling vessel having been provided with at least one thermoelement and containing a determined and calibrated quantity of inoculating agent based on FeSi and sufficient to produce a maximum inoculating effect; allowing the sample melt to solidify while recording
20 temperature changes per unit of time; determining the difference between the minimum temperature in the undercooling phase, the maximum temperature in the eutectic reaction phase, and the eutectic equilibrium temperature T_e ; adding to the base melt thermo-
25 dynamically stable particles of the type spinels or oxysulphides of elements such as magnesium, aluminium, potassium, zirconium, strontium, titanium and rare earth metals when the difference between eutectic equilibrium temperature T_e and the minimum temperature in the undercooling phase exceeds 10 K and when the
30 difference between T_e and the maximum temperature in the eutectic reaction phase exceeds 5 K; and if found suitable repeating these method steps until the afore-said difference falls beneath 10 K and 5 K respectively.
35

2. A method according to Claim 1, c h a r a c -
t e r i z e d by introducing the inoculant on an FeSi-
base in a determined and calibrated quantity of such
5 magnitude that the inoculant content of the melt accom-
modated in the sample vessel will be at least 0.2%
percent by weight.

3. A method according to Claim 1, c h a r a c -
10 t e r i z e d in that thermodynamically stable par-
ticles of the type spinels or oxysulphides are deli-
vered to the melt by immersing into said melt a wire or
rod which consists of at least one outer layer of iron
which encloses one or more of the metals calcium,
15 magnesium, aluminium, zirconium, strontium, titanium
and rare earth metals, and a readily disassociated
oxide, such as iron oxide, in metallic form.

4. A method according to Claim 1, c h a r a c -
20 t e r i z e d in that the supply of thermodynamically
stable particles of the type spinels or oxysulphides is
effected by injecting calcium, magnesium, aluminium,
zirconium, titanium, strontium or rare earth metals
into the melt with an inert gas, together with an
25 oxidizing agent.

5. A method according to Claim 4, c h a r a c -
t e r i z e d in that the oxidizing agent is a readily
disassociated oxide.

30

6. A method according to Claim 4, c h a r a c -
t e r i z e d in that the oxidizing agent is an oxygen
gas or air.

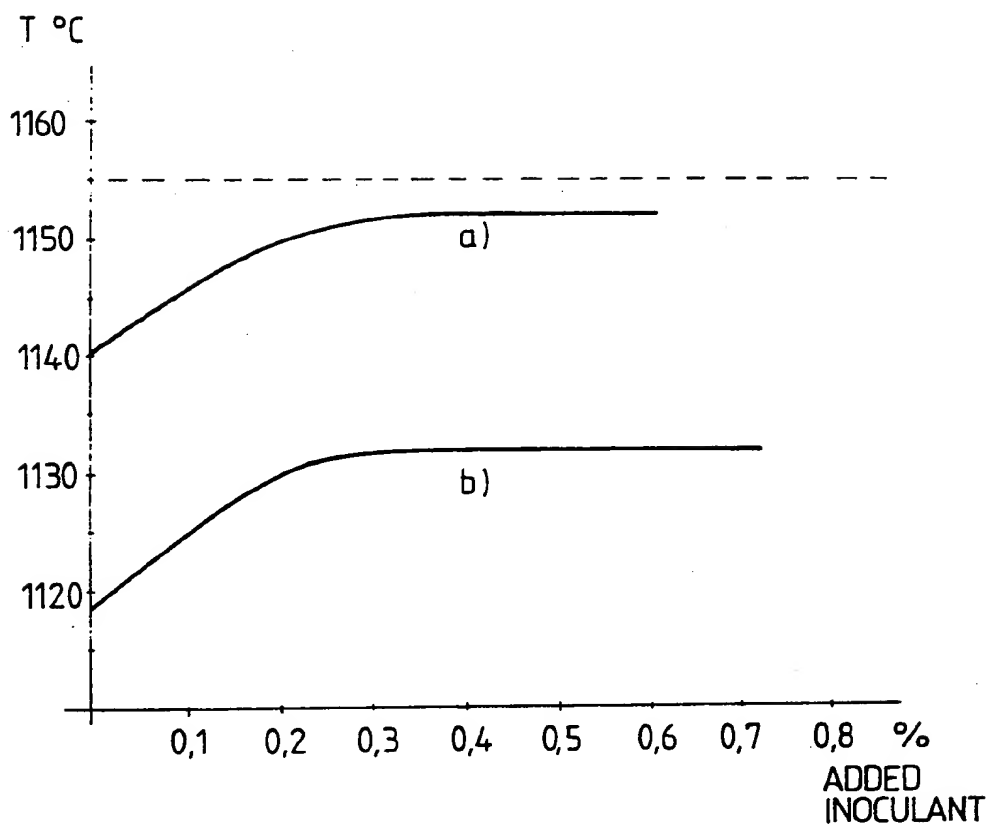
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7. A method according to Claim 1, c h a r a c -
t e r i z e d in that registration of temperature
changes per unit of time is effected in the centre of
the sample melt and in the vicinity of the inner sur-
5 face of the sample vessel, wherein the difference
between the minimum temperature in the undercooling
phase prior to the eutectic reaction and the eutectic
equilibrium temperature is determined with the aid of a
thermoelement positioned adjacent the inner wall of
10 said sample vessel, and the difference between the
eutectic equilibrium temperature and the maximum tempe-
rature in the eutectic reaction phase is determined in
the centre of the sample melt and that the occurrence
of inverse segregation of such magnitude that exudation
15 of the melt occurs is determined by registering a rapid
rise in temperature by the thermal element positioned
adjacent the inner surface of the vessel; and in that
when exudation is registered large quantities of ther-
modynamically stable particles of the type spinels or
20 oxysulphides are added to the sample melt; and in that
the above procedural steps are repeated until said
differences are smaller than 10 K and 5 K respectively
and no exudation is registered.

25 8. A method according to Claim 1, c h a r a c -
t e r i z e d by introducing primary nucleating par-
ticles through the medium of a master alloy which is
produced separately by forming oxides/oxysulphides of
elements such as Cu, Mg, Al, Zr, Sr, Ti and rare earth
30 metals in a melt having low carbon activity and in a
substantially high concentration, said master alloy
being introduced into the melt to be treated in a
manner known per se.

9. A method according to Claim 8, c h a r a c -
t e r i z e d in that the master alloy contains more
than 95% iron.

7/7



UBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00144

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: C 21 C 1/08, C 22 C 33/08														
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%; text-align: left; border-bottom: 1px solid black;">Classification System</th> <th style="text-align: left; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px; vertical-align: top;">IPC5</td> <td style="padding: 5px; vertical-align: top;">C 21 C; C 22 C; G 01 N</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div> <p style="padding: 5px;">SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	C 21 C; C 22 C; G 01 N								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; text-align: left; border-bottom: 1px solid black;">Category *</th> <th style="text-align: left; border-bottom: 1px solid black;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 10%; text-align: left; border-bottom: 1px solid black;">Relevant to Claim No.¹³</th> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px; vertical-align: top;">WO, A1, 8601755 (SINTER-CAST AB) 27 March 1986, see page 7, line 14 - page 8, line 22; page 9, line 1 - page 10, line 23; figures 1-4 --</td> <td style="padding: 5px; vertical-align: top;">1-9</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px; vertical-align: top;">US, A, 4046509 (STIG LENNART BÄCKERUD) 6 September 1977, see column 4, line 62 - column 6, line 2 --</td> <td style="padding: 5px; vertical-align: top;">1,7</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px; vertical-align: top;">EP, A1, 0004819 (COMPAGNIE UNIVERSELLE D'ACETYLENE ET D'ELECTRO-METALLURGIE) 17 October 1979, see page 7, line 35 - page 8, line 12; page 9, line 8 - line 12; page 9, line 36 - page 10, line 7; figures 1-6 --</td> <td style="padding: 5px; vertical-align: top;">1,7</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	WO, A1, 8601755 (SINTER-CAST AB) 27 March 1986, see page 7, line 14 - page 8, line 22; page 9, line 1 - page 10, line 23; figures 1-4 --	1-9	A	US, A, 4046509 (STIG LENNART BÄCKERUD) 6 September 1977, see column 4, line 62 - column 6, line 2 --	1,7	A	EP, A1, 0004819 (COMPAGNIE UNIVERSELLE D'ACETYLENE ET D'ELECTRO-METALLURGIE) 17 October 1979, see page 7, line 35 - page 8, line 12; page 9, line 8 - line 12; page 9, line 36 - page 10, line 7; figures 1-6 --	1,7
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>														
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px; vertical-align: top;"> Date of the Actual Completion of the International Search 21st May 1991 </td> <td style="width: 50%; padding: 5px; vertical-align: top;"> Date of Mailing of this International Search Report 1991-05-31 </td> </tr> <tr> <td style="padding: 5px; vertical-align: top;"> International Searching Authority SWEDISH PATENT OFFICE </td> <td style="padding: 5px; vertical-align: top;"> Signature of Authorized Officer Nils Engnell </td> </tr> </table>			Date of the Actual Completion of the International Search 21st May 1991	Date of Mailing of this International Search Report 1991-05-31	International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer Nils Engnell								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	EP, A2, 0030043 (METALLGESELLSCHAFT AG) 10 June 1981, see page 1 - page 2; page 4, line 13 - line 22 --	1,3
A	DE, A, 2245902 (KARL SCHMIDT GMBH) 4 April 1974, see page 3, line 11 - line 25 --	1,3,4,5, 6
A	DE, A1, 2753853 (CASPER, KARL-HEINZ) 13 June 1979, see page 5, line 19 - page 6, line 20 --	1,4,6,8
A	US, A, 3360364 (KENNETH H. IVEY ET AL) 26 December 1967, see the whole document --	1,3,4,7
A	US, A, 3617259 (HEINZ-ULRICH DOLIWA FRIEDBERG) 2 November 1971, see the whole document --	1,3,4,7
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00144

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